AMSI
AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

National Collaboration in the Mathematical Sciences

Submission to the

Higher Education Base Funding Review

from the
Australian Mathematical Sciences Institute
on behalf of the mathematics and statistics community in Australia.
March 2011

Preamble and context statement

This submission is being made by the Australian Mathematical Sciences Institute following consultation with its membership (almost all Australian university mathematics and statistics departments), the Australian Mathematical Society, the Statistical Society of Australia Inc. and the Australian Academy of Sciences' National Committee for the Mathematical Sciences.

As a general rule we have avoided making responses to questions in the consultation paper which canvas non discipline-specific issues. We have attempted to restrict ourselves to the funding and delivery of tuition in the mathematical sciences.

Context

The greatest single challenge to the health of the mathematical sciences in the nation's universities is the long term decline in enrolments in calculus-based mathematics subjects, often referred to as *intermediate* or *advanced*, at year 12 (see the chart in the appendix and reference 2: the National Strategic Review of Mathematical Sciences Research in Australia). We will not address the causes of this decline here but it is important to note that the decline has meant that, in many regional and low SES areas, these subjects are not taught. This decline has resulted in

- widespread course realignments to cope with increasing numbers of less mathematically literate students,
- reduced graduation rates in the mathematical sciences and stagnating interest in engineering and sciences courses,
- reduced intake into teacher training programs of mathematically qualified graduates,
- reduced numbers of qualified secondary school teachers, especially in regional and low SES areas, leading to fewer students in calculus-based mathematics subjects at Year 12.

Postal Address: Building 161
c/- The University of Melbourne
Victoria 3010 Australia

Email: enquiries@amsi.org.au
Phone: +61 3 8344 1777
Fax: +61 3 8344 6324
Web: www.amsi.org.au

- a significant reduction of the number of institutions offering mathematics and statistics majors with a consequent reduction in staffing,

This decline creates a structural impediment to meeting Australia's galloping demand for mathematics and statistics graduates (see the DIISR document: reference 3) and it puts a brake on the national productivity growth enjoyed by other OECD countries which have no such impediment and where mathematics and statistics graduate levels are, on average, two and a half times higher than those in Australia.

The national strategic importance of our discipline is recognized by government, for example:

"A nation that cannot turn out top-notch mathematicians and statisticians is a nation in deep trouble. Unless we turn around the trends that have bedeviled this discipline over the last decade or so – in schools, in universities and in research – we will not be able to meet our needs for people with a sound knowledge of mathematics"
Kim Carr, 14 Feb 2008

The discipline itself actively pursues programs, supported by government funding, to turn this situation around. Indeed AMSI's very existence is a result of this determination on our part.

Because of the central and fundamental role of the higher education base funding model the mathematical sciences sector believes that the Review should be cognizant of this situation and identify the discipline as one requiring intervention by it to encourage undergraduate enrolments.

Responses

Overall recommendations

In addition to our responses to the Review's questions we propose the following measures be recommended by the Review:

- The discipline's unique status as a service discipline and its impact on delivery costs should be acknowledged.

- University mathematics and statistics subjects should normally be taught by the expert discipline. This measure will not only support mathematics and statistics departments but will produce high quality teaching and learning outcomes. Of course this teaching enterprise may be a joint one with the client discipline but this is to be encouraged. One exception is where statisticians are embedded in other disciplines and teach in-house statistics subjects.

- Honours subjects in all disciplines should be treated separately along with postgraduate coursework. Teaching at this level is more intensive, out of class

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consultation commitments are higher and thesis supervision (typically between 25 and 50 per cent of the year) is particularly intense.

- An undergraduate scholarship scheme to be introduced for students studying mathematics or statistics. This scheme should contain a component intended for students who wish to study the discipline but have been unable to access advanced mathematics subjects at year 12.

- Those first year university subjects designed to bridge mathematically under-prepared students into programs requiring mathematics and statistics should be fully funded by the Commonwealth (that is, HECS-free).

- The strategic intention of the Review's recommendations which impact our discipline (and others) should be embraced by Australia's universities otherwise the intention will be undermined. The Review should recommend measures to ensure that this engagement occurs.

Responses to the consultation paper

Q 1.2 What principles should determine the appropriate balance of resources contributed by:
- Government;
- students; and
- other sources

towards the cost of undergraduate and postgraduate education?

Amongst the various principles to be considered, national need is fundamental to our discipline. For example, we believe that the supply of qualified teachers must be guaranteed. Engineering the balance of government versus student contributions is not by itself effective in meeting national needs and should be augmented by national measures such as those listed in our opening response.

Q 1.3 What other principles, if any, should influence the level and distribution of government subsidies for tuition costs in higher education?

Australia's strategic needs must be met (for example, courses in some languages might not exist without subsidies but access to such skills is needed for Australia's economic and diplomatic engagement in our region). Such an argument can also be made for mathematics and some other technical areas where the skill base has to be flexible to meet rapidly changing circumstances that come with technological development.

Students should not be disadvantaged due to their economic standing or home address. A broader scholarship base, which takes into account the financial needs of the student and their academic ability, would help address this.

Q 2.1 What are the best international measures of course quality that would provide appropriate benchmarks to inform judgements about the appropriate level of base funding for Australian universities?

Mathematics and statistics are naturally international disciplines, as are physics and biochemistry for example. The teaching culture is remarkably uniform across the world with global, organically-formed, teaching standards informed by the mobility of mathematical scientists. This makes benchmarking reasonably straightforward and the simplest and most effective measure is staff/student ratio comparison for like institutions.

The international gold standard for tertiary mathematics tuition is small class teaching with active student engagement (for example, the internationally renowned program at the University of Michigan http://www.math.lsa.umich.edu/undergrad/introprogram/index.html). This means fewer large lectures and more small tutorials in which the students work together. This is relatively easy to achieve in senior undergraduate classes but more difficult at first year where cohorts are large. Staff-student ratios in mathematics and statistics are at historically high levels in Australia and a number of AMSI departments have reported that they have downgraded their emphasis on small class teaching.

Q 2.4 What is the connection between the level of base funding and quality outcomes?

Within each university there is a long path between the administration and the teaching departments. The attenuation of funds depends on internal university budget processes. These vary widely around the country and our discipline had direct experience of this when the cluster funding rate for mathematics rose from 1.3 to 1.6 in 2006. As a result there is not a clear connection between base funding rates and staff-student ratios. Nonetheless the base funding is critical in determining the level of attention individual students can receive, either in class or via support mechanisms (eg online resources, duty tutors, remedial help).

In our view the Commonwealth should make its strategic intentions in setting base funding rates unequivocally clear to the universities.

Q 3.1 Do the current funding relativities reflect the relative cost of delivering undergraduate courses in particular disciplines? What, if any, relative weightings should be afforded to various discipline groups and why?

The short answer for the mathematical sciences is no. As a first pass the parity between the mathematical sciences and computer science is appropriate because of the extensive usage of dedicated computer laboratories and specialist software used in our discipline. However, there are a number of additional factors which need to be considered and make the mathematical sciences more costly than computer science. These include:

Service teaching. We cannot bring to mind a discipline with greater service subject commitments than mathematics and statistics. When the individual service subject enrolments are all small (up to 250), the number of subjects taught per academic in our departments is large compared to other disciplines, including computer science. This service load is not discretionary, the subjects concerned being compulsory in various (accredited) programs. Outside the Group of Eight this situation is common and the diseconomy of scale has a direct impact on departmental workloads and there is a resulting increase in staff-student ratios. Service teaching can account for half a department's subject load where a full mathematics or statistics major is taught and the full load where mathematics or statistics specialization is not available. (Note: even the Group of Eight universities have given up "discretionary" service teaching involved in the preparation of mathematics teachers.)

Remediation. The increasing number of students entering science and engineering programs without advanced mathematics at Year 12 (see the appendix) has led to additional costs. These include the costs incurred in setting up and delivering additional first year subjects, almost continual revision of existing subjects and increased student support costs (drop-in centres, tutors on duty, etc.).

Q 3.2 What are the costs to universities of improving the quality of teaching and the quality of the student learning experience at the undergraduate level and to what extent should they be reflected in the base funding model?

The main factors are staff and infrastructure. The need for well qualified, appropriately trained staff at an acceptable staff-student ratio is clear. The current ratios are unacceptable.

The funding model should also recognise the need for properly resourced spaces where students will study. These spaces include lecture theatres, libraries, tutorial rooms, wet labs and computer labs. For mathematics and statistics computer laboratories are an essential component in undergraduate tuition. These laboratories

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must be in the discipline teaching precinct. This needs to be appropriately recognised in the funding model.

Q 3.3	What are the costs of engaging low SES students in undergraduate education? Should such costs be a factor in determining base funding? How might support for low SES students be maintained in the future?

There are significant costs to the discipline in remediating the absence of advanced mathematics offerings in low SES schools and the high incidence of unqualified mathematics teachers in those areas.

Students from low SES backgrounds may require financial support in the form of scholarships or differential HECS to allow them to attend university. If the students have received adequate secondary training there should be no extra tuition cost for the university compared to other students once the student is enrolled. Otherwise HECS-free bridging subjects should be funded. The need for these mathematics subjects transcends our discipline's interests.

Remark: A key factor in ensuring low SES students receive an adequate secondary education to enable them to access tertiary education is support for universities to engage with key schools via an outreach program to provide professional development to teachers. Such support is currently provided via AMSI (TIMES project etc), CSIRO (Maths by email, Mathematicians in Schools). Some universities have outreach activities (eg University of Sydney's Science Alliance program) but more could be done if there was appropriate funding.

Q 3.4	What additional costs are involved in the provision of work integrated learning and should these be considered in setting the level of base funding?

This varies with discipline and the provision in science degrees is highly variable, including those with mathematical sciences majors.

Q 3.5	What proportion of a higher education teacher's time should be spent on scholarly activity and how could the costs of scholarship be included in the base funding model?

Teachers must engage in scholarship to guarantee genuinely internationally competitive programs. This is true in mathematics and statistics which, contrary to common perception, is a rapidly evolving discipline. There seem to be varying opinions within the discipline on the exact proportion of time to be spent on scholarship and this varies with job classification so we'll leave this question to those better placed to answer it.

Q 3.6	Should any research activity continue to be supported by base funding?

If not supported by base funding, it must be supported by other means.

Q 3.7	Should infrastructure investment continue to be supported by base funding?

If not supported by base funding, it must be supported by other means.

Q 3.8	What other factors, if any, should be taken into account in determining base funding for teaching and learning in higher education?

The base funding must be CPI indexed.

Q 4.1	Is there a higher relative cost for postgraduate coursework degrees? If so why is there a difference and what is the extent of the difference compared to an undergraduate degree in the same discipline?

Yes. There is a more intensive teaching environment with smaller class sizes and greater demand for student consultation. Most postgraduate coursework degrees include a research project component. It is this component that requires one to one supervision and instruction and so it is more expensive than a traditional classroom course of 20-30 students. See also our opening recommendation concerning honours courses.

Q 5.3	Should the basis for determining the level of contribution by the student towards the cost of their tuition be different at the postgraduate level?

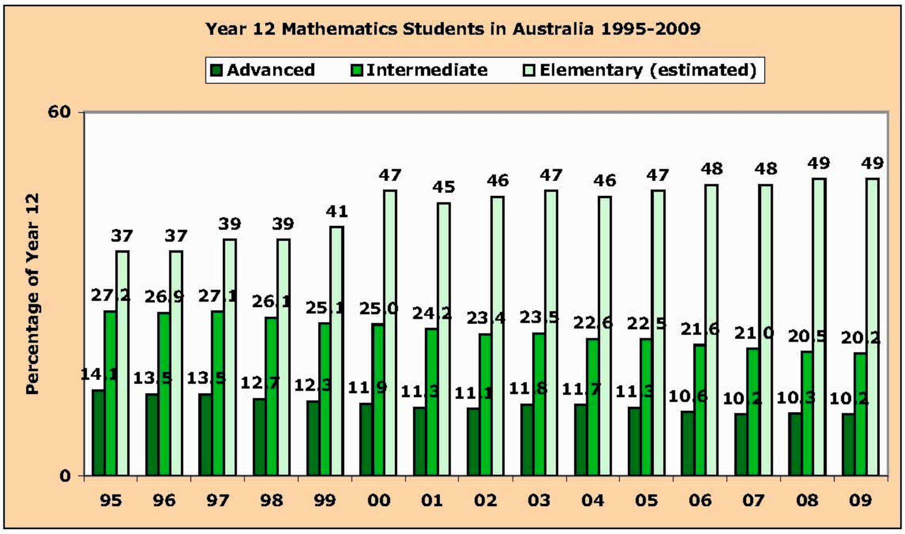
Yes, when national benefit is a factor. For example, in statistics in Australia at the moment there is poor retention from third year to fourth year and from fourth year to a PhD because of employer demand for graduates. The recent DIISR Research Workforce Strategy case study identifies this issue. There is a clear need to give incentives to students and universities in the area of postgraduate coursework in statistics.

Q 6.1	To what extent does the base funding model provide incentives for institutions to invest in and deliver high quality teaching?

In our experience the extent is variable. The incentive is greatest when the funds flow unimpeded to the teaching units and least when central university overheads are a fixed percentage of income irrespective of the discipline. There is also evidence of "code abuse" where subjects are re-badged in order to attract more Commonwealth funds to a particular faculty even though they are not taught by the discipline experts (see our initial recommendation on service teaching).

Appendix

Year 12 mathematics enrolment trends 1995-2009 (Barrington 2011)



The proportion of students studying at least one mathematics subject in their final year of secondary school has remained at about 80% between 1995 and 2009, but the elementary percentage has grown at the expense of the advanced and intermediate percentages (see chart). Thus, about 20% have been taking no mathematics in Year 12.

References

1. Australian Academy of Science. (2006). '*Mathematics and Statistics: Critical Skills for Australia's Future*', The National Strategic Review of Mathematical Sciences Research in Australia.
2. Frank Barrington '*Year 12 mathematics enrolment trends*', Private communication, March 2011.
3. '*Research Workforce Strategy – Discipline Specific Case-Study – Mathematical Sciences*', DIISR, March 2011.

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Web: www.amsi.org.au

Contact details

Prof. Geoff Prince
Director, AMSI
Building 161
c\- The University of Melbourne
email: director@amsi.org.au
phone: (03) 8344 1779